

BRIEF REPORT

on a trip to

ECUADOR, PERU, AND BOLIVIA

May 25, 1923, to February 18, 1924

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CONTENTS

Itinerary	1
Topography and climate	4
Ecuador	5
Agriculture in Ecuador	6
Traveling in Ecuador	7
Horse feed	7
Peru	8
Agriculture in Peru	9
The grazing industry in Peru	10
Bolivia	12
Botanical results	15

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In order to place on record the economic results of the trip they will be here outlined, though the results of technical botanical interest will be presented in detail later for publication. It should be noted, however, that the botanical information obtained is the real basis for a complete knowledge of the grazing industry of the countries visited. For work in Ecuador financial aid was contributed by the Gray Herbarium of Harvard University and the New York Botanical Garden, which institutions shared in the specimens obtained.

Itinerary.

I left New York May 25th on a Panama Railroad steamer for Panama where I remained a few days until I could sail on the Peruvian Line for Guayaquil, at which Ecuadorean port I arrived June 16th.

For two weeks headquarters were made at Guayaquil. Through the kindness of Mr. Orr, geologist, and Mr. Clark, Manager, I was able to spend about a week at the Oil Camp, between Guayaquil and Salinas, where the Standard Oil Company was drilling a test well.

About July 1 I went to Huigra where I made my headquarters for four weeks. Huigra is a station (4000 ft.) on the railroad from Guayaquil to Quito, the only railroad of importance in Ecuador. Excursions were made up and down the railroad and to several places on the coastal plain, namely, to Milagro, a sugar plantation, managed by Mr. Perez, to Teresita, a banana plantation, owned by Mr. Cleveland, and to Plantación Panigón

(Cacao, coffee, and bananas), managed by Mr. Rorer, formerly of the U. S. Department of Agriculture.

About August 1 I went to Quito and arranged for a trip by horses to Tulcán. On this trip I was accompanied by Mr. J. R. McWilliam of Quito, an American missionary, as interpreter and guide. Our route lay through Ibarra and the La Rinconada Hacienda to Tulcán, the journey occupying one week. From Quito a trip was made to Pichincha a volcano near by (15000 ft.).

In the latter part of August I returned to Guayaquil and started on a trip through southern Ecuador which occupied three weeks, accompanied by Mr. McWilliam. We first went by boat to Santa Rosa then by mules to Portovelo, Loja, Cuenca and finally to Huigra on the railroad. At Portovelo is a gold mine, run by Americans, with Mr. Tweedie in charge, through whose courtesy we were given the privileges of the company's houses.

On September 18 I went to Ambato and in company with Mr. McWilliam, went by mule to Baños and into the Oriente a day's journey beyond Baños. I then went to Quito and on the way back to Guayaquil, stopped over at Urbina, a station located at the highest point on the railroad (nearly 12000 ft.). From this place I ascended the volcano Chimborazo to the snow line (about 16000 ft.). I then returned to Guayaquil and prepared to leave for Peru. I packed my plants for shipment to Washington.

On October 11 I left by the Peruvian Line for Callao where I arrived October 17. I went to Lima to make arrangements for a trip to the interior over the Central Railroad. First, I went by rail to

Oroya (12000 ft.) where is located the Cerro de Pasco Company's smelter. From here by automobile I went to Tarma and La Merced and by horse to Colonia Perené (2000 ft.) a large coffee plantation. Returning to Oroya I went to Junín on the railroad about half way to Cerro de Pasco, where I was met and conducted to Atacsaico, a large sheep ranch about 12 miles to the west. At Cerro de Pasco (14300 ft.) I was tendered courtesies by Mr. Phillpot, manager of the Copper Company. I went to La Quinhua and to Goyllarisquisga, a coal mine where I descended by cable over a mile to warmer slopes. I then returned to Lima and left Callao for Mollendo November 14.

Arriving at Mollendo I took the Southern Railroad for Arequipa (7000 ft.) where I remained a few days and went on toward Cuzco to Chuquibambilla (13000 ft.) where there is a Government experiment station in charge of Colonel Stordy, an Englishman. On November 29th I arrived at Cuzco, one of the centers of the old Inca Empire. There is a railroad under construction from Cuzco down through the valley to Santa Ana, which has reached to Kilometer 63 not far from Ollantaytambo. Through the courtesy of the head engineer, I was able to go here and also about 10 miles further down the river. I returned to Cuzco and went back over the railroad to Juliaca and on over Lake Titicaca to La Paz in Bolivia, where I arrived December 9th.

The American Legation and the Consulate in La Paz were very helpful and brought me in touch with people who extended many courtesies to me. In company with Mr. Dagg, an Englishman living in La Paz, I visited Mt. Illimani (22000 ft.), a snowcapped volcano about 40 miles from La Paz and ascended to the glaciers at about 16000 feet. Another trip from La Paz was made into the Yungas, a semitropical region in the Amazon Valley to the

north of Capital. This trip was made through the courtesy of the Director of the newly constructed railroad from La Paz to Pongo. The Director furnished passes for myself and Mr. Otto Buchtien, who accompanied me as guide and interpreter, and furnished mules for a week's journey through North and South Yungas, a great coca-growing region. Mr. Buchtien is a German botanist long resident in Bolivia. On January 3 I arrived at Cochabamba where I spent several days in a fertile semitropical agricultural valley.

The last excursion in Bolivia was to the southern border over the transcontinental railroad to Buenos Aires. This has not been completed but is under construction from Atocha to Villazon. Through the kindness of Mr. Trueheart, manager of the Ulen Contracting Corporation that is constructing the road I was furnished with passes on construction trains and with a man and mules for overland travel between railheads. The round trip took about ten days. Coming back to Uyuni I went to Antofagasta, Chile, where I embarked on a Grace Line Steamer for Panama January 25th. I arrived in New York February 17th.

Topography and Climate.

The three countries lie mostly in the Andes, or Cordillera as the great mountain system is called there. Along the Pacific coast is a plain varying in width from a few miles to as much as 100 miles. East of this is the mountain system consisting for the most part of two main chains with high valleys or plateaus between. On the east of the mountain system the slopes and foothills merge gradually into the Amazon Valley in the north and into the Paraguay Valley in the south.

The countries lie entirely within the Tropics and the climate is tropical but is profoundly modified by the great altitudes of the mountains. The coastal plain is well watered in northern Ecuador but is one of the driest deserts in the world in Peru. The Eastern slope is moist and in many places is covered with tropical rain forest. In the mountain region the rains are distributed unevenly and there is usually a well marked rainy and dry season. Further details will be considered under each country.

Ecuador.

The coastal plain is a rich agricultural country with a high rainfall in the northern part which is similar to the Colombian plain to the north. The rainfall decreases toward the south, especially in the vicinity of the coast. Around Salinas, at the point of land west of Guayaquil, arid conditions prevail, though further inland the rainfall is sufficient for crops. Toward the Peruvian border the aridity increases rapidly and soon desert conditions prevail as indicated below under Peru.

The Cordillera consists of two main chains with several cross ridges and valleys between. Tulcan, Ibarra, Quito, Ambato, Riobamba, Cuenca, and Loja, the important cities of the mountains, are all in valleys or depressions and the connecting roads pass over ridges. The valleys are from 7000 to 10000 feet altitude, while the eastern and western main chains rise to several thousand feet higher. The Cordillera above tree line is usually called the Sierra. Several peaks rise to such heights that they are permanently snowcapped. Of these Chimborazo and Cotopaxi are the

better known, rising to an altitude of more than 20000 feet.

On the eastern side of the Cordillera the terrain slopes to the Amazon valley. The eastern part of Ecuador lying in the margin of this great valley is called the Oriente. It is covered with dense rain forest and is only partly explored. The wooded slopes of the eastern Andes are known as montaña.

Agriculture of Ecuador.

The chief products of the coastal plain are cacao, sugar, ^{coffee} rice, and bananas; in the elevated valleys, corn, beans, alfalfa, cotton, wheat and barley. In the uplands there are many ranches. The páramos or elevated plains and hills above tree line are well supplied with nutritious grasses and will support a large number of cattle. At present the number is far below the ultimate limit. Cattle and sheep can range over these páramos throughout the year up to the snow line which is usually from 15000 to 16000 feet. The water supply is sufficiently abundant.

A large ranch was visited in northern Ecuador. This ranch, owned by Sr. Don Virgilio Tamayo, is called Hacienda La Rinconada. It lies at an altitude of 9000 to 10000 feet and comprises several square miles of land extending to the Colombian border.

It supports 2500 head of cattle but would support much more stock. The stock graze on the native grasses. For the use of horses and milk cows the owner raises tame grass and alfalfa. The latter is cut every four months. The chief crops are potatoes and barley.

Three large plantations were visited by me on the coastal plain. The first was a sugar plantation at Milagro; the second a plantation managed

by Mr. James Rorer, formerly of the U. S. Department of Agriculture, where the chief crops were cacao, coffee, and bananas; the third at Teresita, near Bucay owned by Mr. J. A. Cleveland, chiefly devoted to bananas.

Traveling in Ecuador.

A railroad runs from Guayaquil to Quito, passing through Huigra, Riobamba, and Ambato. Other important places lie at some distance from the railroad and must be reached by horse or mule. As indicated under itinerary three trips were taken to outlying points. For these trips mules (or horses) were hired for specific portions of the trip, or sometimes for the entire trip-- depending on the length. The horses included a riding animal for myself and one for the interpreter, and often also one for the muleteer, the Indian who had charge of the animals. One or two animals were necessary for the "cargo" or pack. I brought from Washington my own saddle, a 11-inch McClellan army saddle, since the native saddles are uncomfortable. I carried a folding cot and mattress pad together with two blankets and a water-proof poncho, because many of the inns or huts where one must spend the night are unprovided with beds or the beds are uncomfortable and unsanitary. It is necessary to take with one a supply of food to supplement that which may be obtained from the country. The páramos are cold because of the altitude and plenty of warm clothing must be taken.

Horse feed.

It is interesting to note the kinds of horse feed available. No grain is fed to saddle or pack animals. When an outfit reaches a stopping place for the night horse feed is the first item to which attention is directed. Where alfalfa is grown it is the most satisfactory feed. Other feed obtained was

green barley, green corn, and green sugar cane. In southern Ecuador between Santa Rosa and Loja brown sugar was commonly fed to animals. This comes in cakes like small bricks and is called raspadura. It is made by boiling down the raw sugar juice without purifying in any way, giving a dark brown mass. Animals are very fond of it. Another feed for animals is obtained from a wild grass which has been brought under cultivation by transplanting the roots. This is *Axonopus iridifolius* and is called gamalote (or gramalote). The grass is cut and fed green like alfalfa.

Peru.

In a general way the main subdivisions into coastal plain, Cordillera, and oriente continued from Ecuador into Peru. The coastal plain is extremely arid and constitutes one of the most desert regions of the world. In much of the region rain falls only at intervals of several years-- sometimes as much as fifteen. There are several rivers from the mountains that flow to the sea. To the valleys of these rivers the agriculture is confined. The soil is fertile and when irrigated from these rivers produces abundantly. The chief crops here are cotton, sugar, and fruits, especially the grape. The Cordillera or Sierra contains two or three ranges and includes several high, snowcapped peaks of over 20,000 feet. The valleys between are in the central and southern part expanded into broad plateaus of 12000 to 14000 feet elevation. These uplands are called Punas and correspond to the páramos of Ecuador.

In Peru the rivers in the valleys of the north and central part flow to the north and finally east to join the Amazon. Iquitos in the north-eastern part lies

on the Marañon river at an altitude of only 350 feet and ocean steamers ascend to this point from the Atlantic Ocean. As one passes down these valleys one goes from the temperate into subtropical and tropical regions in rapid succession. On the eastern slope of the eastern Cordillera the conditions are similar to those found in the Oriente of Ecuador.

Agriculture of Peru.

Cotton and sugar have been mentioned as the chief products of the coastal plain. In the Sierra and at intermediate altitudes the crops are barley, wheat, potatoes, beans, corn, and alfalfa. In the subtropical valleys coffee is important. In the forests of the upper waters of the Amazon rubber has been important but within recent years the rubber industry has suffered from the competition from the East Indies.

At 12000 feet altitude crops for the most part are wanting though some things can be grown in protected places. Barley and beans are grown at the highest altitude, then, at a somewhat lower altitude, come corn and potatoes, then wheat and alfalfa.

There are certain indigenous crop plants used at high altitudes by the natives. Among the more important of these are quinoa (Chenopodium quinoa), oca (Oxalis tuberosa) and papa lisa (Ullucus tuberosus). The seeds of quinoa are used for porridge; the tubers of oca and papa lisa are used in the same manner as potatoes. All are grown at high altitudes.

An important crop of the semitropical valleys is coca which will be

referred to under Bolivia, as in that country it came under my personal observation.

The Grazing Industry in Peru.

The high valleys and punas of Peru are covered with an excellent growth of grass. I visited two ranches in Peru and had an excellent opportunity to observe the methods used there in the sheep-raising industry. The first was at the Atocsaico Ranch, twelve miles southwest of Junín on the railroad from Oroya to Cerro de Pasco. From Oroya (12000 ft.) to Cerro de Pasco (14300 ft.) there is a gradual ascent through a plateau partly of hills and partly of level valley land.

The ranch contains many thousand acres and is devoted primarily to sheep-raising for wool. They keep about 35000 sheep, 1100 cattle and some horses. The sheep graze the year round and there is plenty of running water. The grass is abundant and the quality is as fine as I have seen any where. There is an electric power house with water power. From this there is electric light and stoves and the power runs the wool press and a circular saw. The sheep are dipped in a modern dipping arrangement and the cattle are vaccinated for black leg. The fences, equipment, and outfit generally ^{are} ~~is~~ up-to-date and in good condition. They allow 2 sheep to 3 acres and consider 1 cow equal to 7 sheep in grazing. About 60 tons of wool are produced each year. There was an equipment for shearing sheep by machinery but it is not used as it was found that the shearing was too close and the shorn sheep suffered from the cold at that

altitude. The excess of sheep are sold for mutton. As a by-product there are the skins of these and of those that die from other causes. The sheep suffer from the attacks of foxes and condors. These are shot and a bonus paid on presentation of the dead animals. The labor comes from Indian families who are kept as tenants contributing a definite amount of time. The quality of the sheep is kept up by importing 50 rams from Argentina every third year. As there are no trees on the place (above timber line) timber must be purchased. The cheapest source of timber is old ties of Oregon fir bought from the railroad. The defective wood is removed leaving the sound interior. Poles are brought up from Tarma to be used as secondary posts between the larger ones of the Oregon fir. The principal fuel is peat from turf. The ranch makes its own lime from the native limestone using sheep manure as fuel. With the lime cement is made for walls and buildings,

The next ranch visited was the Government Experiment Station at Chuquibambilla on the high plateau between Juliaca and Cuzco. The altitude here is about 13000 feet. There is a gradual rise from Juliaca to La Raya and then the railroad descends to Cuzco (about 11500 feet). The plain or broad valley narrows to the summit at La Raya. The director of the station is Colonel Stordy, an Englishman. The ranch contains 18000 acres upon which there are now 15000 head of sheep. The native sheep are being improved and the stock built up by means of imported European (English, Scotch, and French) rams. The equipment is modern, including a good cement dipping tank. The grass

is abundant and the grazing good. Modern methods are used in caring for the sheep. It was lambing season while I was there. The ewes' udders were being washed (before lambing) with a disinfecting fluid to prevent a certain disease among the lambs (a serious-- usually fatal-- dysentery). At one farm there were 1500 lambs one or two days old. A sleet storm came up and the mothers tried to protect the lambs by standing over them. Ichu grass (Stipa ichu) is abundant on the hills, growing in bunches. This is not considered a good forage grass as it is coarse and wiry, but it was snipped and nibbled by the stock, mostly horses, cattle, and llamas, rather than sheep.

While at Oroya I took an excursion down the eastern slope to the Colonia Perené on the Perené river. This is a coffee plantation at an altitude of 2000 feet. There are here 1600000 coffee trees.

Two grasses are grown here for green feed for the work animals on the place. One is guinea grass, called here zaina (Panicum maximum). The other is the same grass mentioned as grown by Mr. Cleveland at Teresita, Ecuador, and there called gamalote (Axonopus iridifolius). Here the name is maicillo (little maize). The wild plants were transplanted to the field.

Bolivia.

Bolivia lacks the coastal plain as it is cut off from the Pacific Ocean. The western range of the Cordillera forms the boundary between Bolivia and Chile. The eastern Cordillera passes south from Peru and bends to the eastward and then south gradually merging into the plateau which extends south into Argentina. Thus the western part of Bolivia is a great elevated plain from Lake Titicaca to Argentina, mostly 12 to 13000 feet altitude, and

400 miles long by 100 to 200 miles wide. All the western part of this plain drains into Lake Titicaca and Lake Poopo, an inland basin. The waters of the latter are salt and the southwestern part of the plain is a salt desert containing besides common salt many other minerals, especially borax.

North of La Paz the eastern range slopes off into the Yungas region which is montaña or wooded slope. Still further north lies the Beni the rain forest of the Amazon valley. This is sparsely inhabited except by Indians and formerly was exploited chiefly for rubber. Trinidad is the chief town of this district.

The eastern part of Bolivia is a plain sloping to the Paraguay river which forms the boundary between Bolivia and Brazil. This plain merges on the south into the plains of northern Argentina, the drainage being into the Paraguay river. The southeastern part is called the Chaco. Some of this territory is in dispute with Paraguay. The eastern part of Bolivia is the Santa Cruz region, mainly devoted to stock-raising, with Santa Cruz as the chief town.

The climate becomes more arid toward the south and much of the region, especially toward the southwest, is desert.

Most of the inhabitants of Bolivia are to be found in the southwestern fourth of the country from Lake Titicaca to the provinces of Cochabamba and Tarija, excluding the western parts of the provinces of Oruro and Potosí which are alkali deserts.

The main industry of Bolivia is mining, but agriculture occupies an important position. Much of the alto or high plain is too cold for crops. Barley and beans are grown in protected places. These crops and potatoes, wheat, and alfalfa are grown on slopes and high valleys down to the montaña

(the forested slopes). The beans referred to are called habas and are the same as the broad bean of Europe (*Vicia faba*, *Faba vulgaris*), with large flat dark-colored seeds. I visited Cochabamba which lies in one of the fertile agricultural valleys on the eastern slope of the Cordillera. La Paz, the capital, lies in a bowl 1500 feet below the level of the alto (13500 ft.). At the higher altitudes are found the native crops quinoa, oca and papa lisa mentioned under Peru.

An important crop in the Yungas region is coca. The industry represents large amounts of invested capital as coca farming is a special branch and requires technical skill. The hillsides are carefully terraced and much attention is given to the bushes. The seedlings are raised in seed beds, protected when young as with tobacco and transplanted to the terraces. The picking is also a process requiring skill as in the case of tea. The coca leaves are shipped in bales or sacks to the alto where they are extensively used by the Indians. The leaves are mixed with specially prepared ashes and chewed. Nearly every male Indian has a quid of this distending one of his cheeks.

Bolivia is fairly well provided with trunk-line railroads. Railroads run from La Paz to Mollendo in Peru and to Arica and Antofagasta in Chile. A branch from the latter goes south and ultimately will connect with the main line at La Quiaca in Argentina for Buenos Aires. At present there is a break in the region of Tupiza in the south over which the road is now under construction. Through the courtesy of the Ulen Contracting Corporation I was able to go over this break from Atocha to La Quiaca. A branch line goes to Cochabamba and another to Potosí.

Botanical Results.

Since the Gray Herbarium of Harvard University and the New York Botanical Garden contributed funds for the work in Ecuador, the collections here included all kinds of flowering plants. These were made in triplicate, sets going to the institutions mentioned and to the National Herbarium.

The total number collected in Ecuador was 2136 (19914 to 22050). In Peru and Bolivia collections were confined to the grasses, as follows: Peru, 507 numbers; Bolivia, 364 numbers. In addition 20 numbers were obtained at La Quiaca, Argentina, and 9 numbers at Antofagasta, Chile.

The Grass Herbarium is fortunate in possessing already a good collection of grasses from Bolivia obtained by Dr. Otto Buchtien. Also we have the types of species described by Hackel and by Pilger from these regions. Recently we obtained the grasses collected by McBride and his assistants in Peru. Altogether we have material for a satisfactory account of the grasses of the central Andean region.

A. S. Hitchcock



1375. Chuquibambilla, Peru. Government Experiment station on the high plain in the Andes (13000 feet). The station is especially interested in the sheep-raising industry and in improving the grade of sheep (see page 11).



1307. Hills about Cerro de Pasco, Peru (14500 feet). The grass, *Aciaachne pulvinata*, is a curious tussock-forming species, confined to high altitudes in the central Andes. It is known locally as moss grass and is of no value as forage.



1205. A sheep ranch (Atcesaico Ranch) on the high plain of central Peru near Junín a station on the railroad from Oroya to Cerro de Pasco (13000 feet). The ranch is devoted mainly to sheep raising. Some of the sheep are here shown in a corral. The lambs are to have their tails cut off and the males to be castrated.



1374. Sheep feeding upon the high plain at Chuquibambilla (see page 11). The large grass is ichu grass (*Stipa ichu*) which is eaten rather sparingly because so wiry and woody. The sheep are feeding mainly on the smaller grass between the bunches of ichu.



1226. On Chimborazo, Ecuador, at 14000 feet. Luxuriant growth of grass (mostly Festuca) in background; tussock plants in a bog in the foreground.



1343. A general view of the high plain of Peru near Chuquibambilla north of Juliaca. The railroad runs from Juliaca to Cuzco. The general level is about 13000 feet with mountains rising higher. This is fine grazing for sheep.



1344. A continuation of 1343. The high plain of southern Peru. The white plant in the foreground is a woolly cactus.



1378. Washing the udders of ewes to prevent dysentery in lambs. Chuquibambilla Experiment Station (see page 12).



1371. Dipping apparatus at Chuquibambilla Experiment Station, Peru. On the high plain (13000 feet).



1315. Continuation of 1371.



1347. A water tank at the Chuquibambilla Experiment Station. Although in the tropics, freezing temperatures are frequent, especially at night, and the pipes are wrapped with ichu grass to prevent freezing.



1400. Inca ruins at Ollantaitambo, Peru. On the lower part of the slope are seen a series of terraces supported by stone walls. The level ground of each terrace was used for the cultivation of crops under irrigation. The terraces are in ruins and are not now used.

1592



1592. A dry river bed in southern Bolivia near Tupiza. At times of heavy rains, heavy floods pass down this valley. The main road from Atocha to La Quiaca passes down this river bed which is dry during the greater part of the year. The region is a desert subject to occasional heavy rains.

1577



1577. The high plain in southern Bolivia (12000 feet). The town of Uyuni can be seen in the distance and desert shrubs in the foreground.

1551



1551. A heavy 2-wheeled covered vehicle much used in southern Bolivia. Sacks of ore brought down from mountain mines lie at the right.



1203. A cultivated valley in northern Ecuador. A field of barley in the foreground. Cultivated fields are carried up on the slopes of the mountains as far as practicable, sometimes when the steepness would seem to preclude culture. Such fields are worked by hand.



1580. A river bed in the desert region of southern Bolivia, near Atocha. The stones inclosed in heavy wire netting are used to protect river banks against erosion in times of flood.



1358. Terraced fields near Arequipa, Peru. In the rich valleys the ground is often cultivated to the limit, using every available foot of soil.



1363. A fertile valley near Ollantaitambo, Peru. The upper part of the valley is terraced. These same fields and terraces were used by the Incas.



*The coca plants are in the better details not
clear, trees here and there on the slope*

1500. A coca plantation in the Yungas, Bolivia. The slopes are carefully terraced and planted to the coca shrub. Coca-raising is the chief industry in this region which lies north of La Paz on the Amazon slope of the Cordillera (or Andes).



1438. A small irrigated valley among arid hills along the railroad above Arequipa. The crops are habas (broad bean), alfalfa and barley. Altitude about 10000 feet.



1425. A bridge across the river at Ollantaitambo, Peru. The large rocks at the base of the central pier were placed by the Incas. The wall above is modern.



1513. Sacks of coca ready for shipment at the end of the new railroad north of Cuzco.



1492. In the coca region of the Yungas, Bolivia. The fields on the hillsides are mainly coca plantations. The fields are carefully terraced and planted to the shrub. The seedlings are raised in beds and protected like tobacco, and later planted in the trenches in the terraced fields.



1516. Mules loaded with bundles of coca leaves, Ollantaitambo north of Cuzco. The coca is coming up from the warmer regions to be used on the uplands.



1120. A pile of Panama hats at Guenca, Ecuador. The hats are unfinished being wrapped for shipment.



1134. Our caravan on the way from ^{to Loja} ~~Ambato~~ to Baños, Ecuador. The sacks contain my cot and mattress, and my collecting outfit, such as plant papers. The man with the cowboy hat is Mr. McWilliam, my guide and interpreter.



1235. A deep gorge on the way to Baños, Ecuador. The scenery in this region was magnificent. This is on the eastern slope of the Andes as the road drops to the Amazon Valley.



1130. A native plow. The man is a negro. Negroes are not common at the upper altitudes (this was at Loja, about 7000 feet), but are found mostly in the lowlands.



1345. An adobe wall at Chuquibambilla, Peru. The plain here is 13000 feet. In the distance is a snow-capped range of mountains.



1336. The main building at the Chuquibambilla Experiment Station. The walls on either side of the road are made of adobe bricks covered with mud plaster.



1220. The market plaza at Ambato, Ecuador.



1216. A station on the railway in the highlands of Ecuador. The cows are driven to the station and the fresh milk sold to the passengers.



1487. A beautiful mountain gorge between La Paz and the great snow-capped mountain Illimani.



1277. Breadfruit trees at Colonia Perené on the Amazon slope of central Peru. This is a coffee plantation with 1,600,000 coffee trees (altitude about 2000 feet.)



1256. A railway station in the high Andes on the way to Oroya.



1314. A stone hut used by peasants at Atocsaico ranch central Peru (13000 feet). A door but no windows.



1573. A hut at Uyuni, southern Bolivia, made of adobe and standard oil cans.



1377. A peasant's hut on the Umaquibambilla ranch, made of turf and thatched with grass (13500 feet).



1189. Carrying water in Otavalo, Ecuador.



1338. General view of Chuquibambilla Experiment Station. The high plains at 13000 feet.



1300. The ranch houses at Atoosaico Ranch near Junín, Peru. Devoted mostly to sheep raising. Altitude 13000 feet. No crops are raised so high. The fuel is turf or peat.



1150. The corral at the principal hotel in Loja. This was also the toilet room as there is none in the hotel building. The corral is a very filthy place. In the foreground is an open well. One needs here to boil all drinking water.



1556. Erosion figures in southern Bolivia, north of Tupiza. The road lies in the river bed in the foreground. An arid region.



1196. A badly cut-up road in northern Ecuador. The main thoroughfare between Quito and Tulcan.



1230. On the way from Ambato to Baños, Ecuador. A typical road in the cultivated valleys. Hedges of century plants (Agave).



1184. Frailejones. A tree-like composite with woolly-white leaves. The plants form vast forests over the hills for miles in northern Ecuador. The stems are up to 10 or even 15 feet in height. (*Eulcittium* sp.)

Eulcittium



1185. On the ranch of Sr. Don Virgilio Tamayo in northern Ecuador. A fine melastomaceous shrub. Ranch called La Rinconada.



1144. A partly constructed house near Cuenca, Ecuador, showing the frame work. The heavy pieces are of wood, the smaller cross pieces of carrizo (*Arundo donax*), a large grass.



1119. A hut under construction, showing the use of fiber from agave to tie the roof pieces in place.



1145. A house like that shown in 1144, the framework filled in with mud. This will later be plastered with adobe or with plaster to give a smooth surface.



1202. A common type of hut in the uplands. The walls are of adobe bricks plastered with mud and white-washed. The roof is thatched with grass. These huts usually have no windows and no chimneys. The trees are eucalyptus, which is commonly planted at 8000 to 10000 feet. It is introduced from Australia and is what we call in California blue gum. The picture taken in northern Ecuador.



1450. A hut in the valley north of Cuzco, Peru. The sides are of brush, and the roof of corrugated iron held down with stones.



1310. Indians at Urbina, Ecuador. This is the highest point on the railroad (about 12000 feet) from Guayaquil to Quito and is the station from which I reached Chimborazo. The house is of split bamboo.



1110. The hotel at Huigra (4000 feet) on the Guayaquil-Quito railroad. The walls are of split bamboo.



1313. An Indian house at Urbina (see 1310). The walls are of split bamboo boards. This material is much used for houses in the lowlands. On the uplands the material is mostly adobe but this house belongs to the railroad and the bamboo was brought from Guayaquil.



1118. A close view of bamboo boards (see 1310, 1110, 1313). The bamboo is native on coastal plain of Ecuador. The stems grow as much as 80 feet tall and 7 inches thick at base. The stems are slit and finally split and flattened out, the remains of the partitions being smoothed off with an adz. The boards are mostly 12 to 18 inches wide.



1113. A wealthy man's summer residence at Huigra (4000 feet). The walls are of two thicknesses of bamboo boards, covered with plaster or stucco.



1431. Blocks of stone much used for buildings at Arequipa, Peru. It is somewhat porous, easily shaped, a beautiful color (white or pink) and hardens by weathering. The quarries are close to the surface.



1316. A pile of turf drying for use as fuel at the Atocsaico ranch, central Peru. At this altitude (13000 feet) there are no trees and the fuel is mainly dried turf from mucky land--a sort of peat.



1525. A remarkable peat farm north of La Paz (about 14000 feet). The piles are blocks of peat drying for shipment by rail to La Paz and other points for use as fuel. The peat is said to be 50 feet deep and extend over several square miles.



1440. Piles of fuel at a station along the southern Peru railroad. On the uplands there is no timber and brush and roots of shrubs are used. In the foreground are fagots of brush; in the background piles of roots. These are brought in from the surrounding country by Indians to be used by the locomotives.



1479. A pile of roots to be used for fuel (see 1440).



1214. eucalyptus wood used for fuel by locomotives at Iwisa, Ecuador.



1569. A pile of yareta, much used for fuel in the uplands of Peru and Bolivia. Yareta is a large very close-growing tussock plant found in the high mountains at 14000 to 16000 feet. The plants are brought down by Indians on burros or llamas. The pieces shown in the picture are made by breaking up the big tussocks with an ax. At this station there were 2 loaded cars and many car loads in piles. The plant is *Azorella monanthos*.



1413. A stone wall near Cuzco with cactus growing on top to prevent people from climbing over-- a common protective method. The trees are Eucalyptus.



1250. A dirt wall on the uplands of Ecuador, near Ambato. The moist dirt or earth is tamped into forms of wood and hardens with age. A common method for making fences.



1350. The cathedral and plaza at Arequipa, Peru. Mt. Chachane. in background (20000 feet).



1430. The rich agricultural valley of Arequipa, Peru. A field of alfalfa in foreground. The animals are tethered on the stubble. The trees are Eucalyptus and willow (*Salix humboldtiana*). Mt. Chachane in background (20000 feet).



1385. A cultivated valley at Ollantaitambo, north of Cuzco, Peru. The crops are mainly corn, alfalfa, potatoes, beans (broad bean, *Vicia faba*), and barley.



1572. A lime kiln, near Uyuni, southern Bolivia. The lime stone is in a layer at or near the surface, all over the plain. The fuel is fagots of a desert shrub obtained nearby.



1581. Llamas at Atocha southern Bolivia. They feed on native vegetation while traveling and chew the cud at night. They are given no grain nor forage.



1579. A herd of llamas at Atocha, Bolivia. The llama is the beast of burden of the Indian. A llama will carry about 75 pounds and a herd travels about 10 miles a day, feeding as they go.



1318. A herd of llamas at Cerro de Pasco, Peru. The llama is used only in the highlands and only by the Indians. The white man does not consider them sufficiently efficient.



1545. Llamas at rest, Atocha.